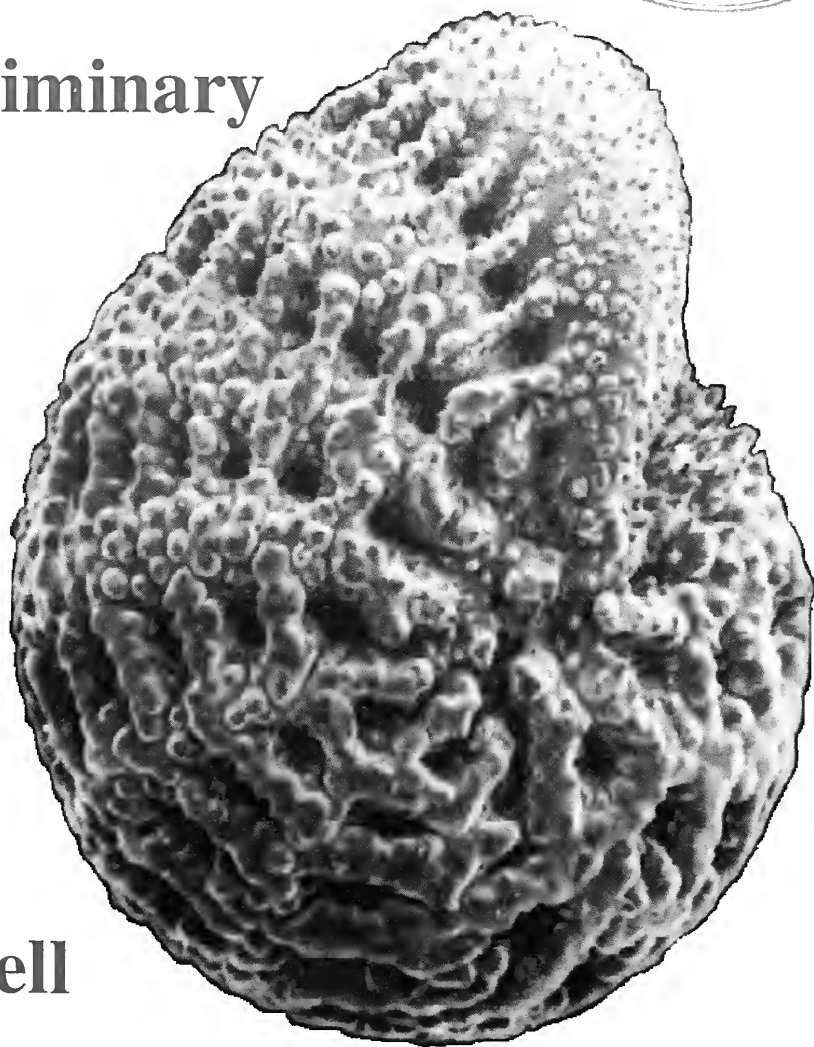


# Foraminiferan Faunas of the Tamar River and Port Dalrymple, Tasmania



## A Preliminary Study



**K N Bell**

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## Foraminiferan faunas of the River Tamar and Port Dalrymple, Tasmania: A Preliminary Survey

K. N. Bell

Honorary Associate, Department of Invertebrate Zoology, Museum of Victoria,  
Swanston Street, Melbourne, Victoria, Australia, 3000

### Abstract

Four foraminiferal zones are distinguished in the Tamar estuary. Effects of poor tidal flushing and/or pollution cause about half the River Tamar to have no foraminiferal fauna. A total of 103 species was found but with very low living numbers. One new species, *Leptohalysis collinsi*, is described.

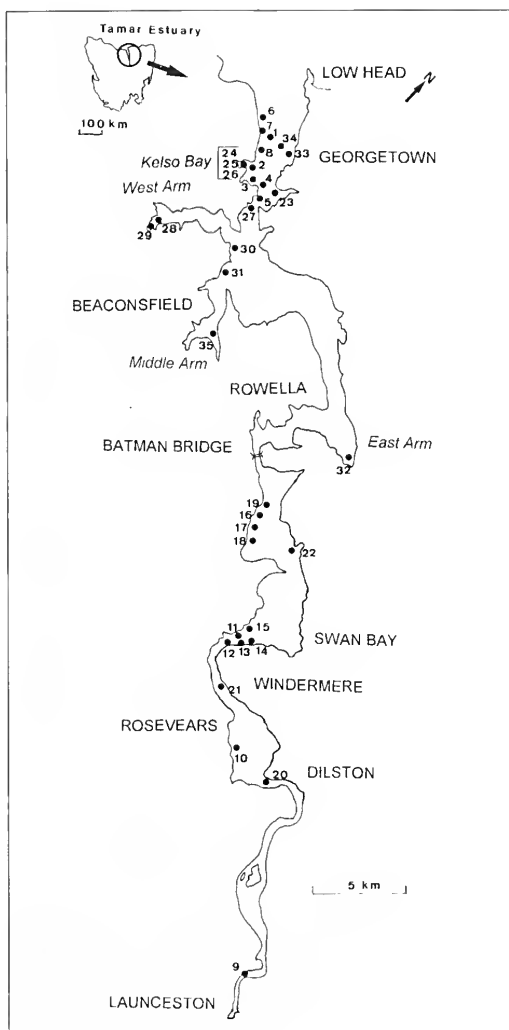
### Introduction

Tasmania is the forgotten appendage to Australia as far as studies on the Recent foraminiferal faunas are concerned. Whilst the faunas of the other states are tolerably well known, the recent foraminiferal faunas of the shallow Tasmanian waters are virtually unknown; a few studies on the deep waters (100-1100 fathoms) have been made (Chapman 1915, 1941; Parr 1950). This is an account of the faunas of the River Tamar and Port Dalrymple in north-central Tasmania.

The River Tamar-Port Dalrymple system is a 63 km long estuary extending from Launceston to Low Head in a NNW direction (fig. 1). Gee and Legge (1979) point out that the system is not a drowned river valley; the sinuous course is due to volcanic extrusions on Tertiary sediments which occupy a slip-faulted and tilted trough (Longman, 1966). Over much of its length the river flows between Jurassic dolerites and Tertiary non-marine sands and gravels, with a small outcrop of Lower Permian mudstones, limestones and sandstones in the northern sector.

### Physical Characteristics of the River Tamar System

Very little study has been reported on the physical and chemical characters of the River Tamar and Port Dalrymple. It is known that the tidal regime is transitional between semi-diurnal and diurnal with an approximately 6 hour flood tide and 7 hour ebb (Phillips 1975; Pringle 1982) and that the tidal range is approximately 3 metres at George Town and 3.5 metres at Launceston (Pringle 1982). Water temperatures are relatively constant with depth and show no stratification in summer or winter although in the river reaches south of about Dilston bottom water temperature is about 0.5°C higher than surface temperatures in winter (pers. comm. W. Wood and J.R. Hunter 1992). Bottom salinity values vary in a regular manner from normal marine (about 35.3



**Fig. 1**  
Tamar estuary and Port Dalrymple showing sample sites.

ppt) in Port Dalrymple to about 18 ppt at Dilston and freshwater (<1 ppt) at Launceston in both summer and winter; in summer the bottom salinities are slightly higher in the southern part of the River Tamar than in winter (pers. comm. Wood and Hunter 1992).

The middle section of the estuary, between Dilston and Batman Bridge, is fringed with a thick almost continuous, sward of *Spartina anglica* (Phillips 1975; Pringle 1993). This has the effect of making the river channel and the once extensive tidal flats inaccessible as most beaches and private jetties are now surrounded by wide, thick, impenetrable *Spartina*. Also, due to the trapping of silt by the plants, the river banks have been increased in height and the tidal stream more confined to the main channel (Phillips, 1975).

## Methods

Samples were collected in the river channel using a pipe dredge; a small grab was initially tried but, due to the hard compacted nature of the river sediments and the small amount of sediment due to scouring, in many localities it proved unsuccessful. In shallower waters the grab was used and intertidally samples were simply scraped off the surface. All samples were preserved in 70% alcohol. For study they were washed, stained in rose Bengal for 12 hours, rewashed and air dried; the foraminiferans were then concentrated using carbon tetrachloride.

## Fossil Faunas

Most samples upstream from Rowella had numbers of worn, often pyritized and reworked Recent species present; these were of much larger size than the present day fauna and were not included in the study. It may be that this fauna represents a period of colder climate but a detailed study has not yet been made.

Samples 28 and 29 from West Arm, north of Beaconsfield, contained a well preserved Permian foraminiferan fauna of at least 11 species that included *Hyperammmina elegans* (Cushman and Walters), *Ammodiscus multicinctus* Crespin and Parr, *Ammodiscus oonahensis* Crespin, *Digitina recurvata* Crespin and Parr, *Lugtonia* sp., *Ammobaculites* sp. cf. *A. woolnoughi* Crespin and Parr, *Trochammmina* sp., *Spiroplectammmina* sp. cf. *S. carnarvonensis* Crespin, *Pelosina* sp., *Calcitornella stephensi* (Howchin) and *Fronducularia* sp. (identifications after Crespin 1958). A more detailed discussion of this Permian fauna is in preparation.

## Distribution and Foraminiferal Zones

A total of 104 species, belonging to 57 genera, were recovered. The number of live specimens was extremely low (much less than 0.01%) except in the intertidal zone so the total fauna (L+D) of each sample was identified (Appendix 2). In moving upstream from Port Dalrymple the number of species and of specimens fell dramatically - from 70+ species/samples near the Bass Strait entrance to only 2 at Dilston and none at all near Launceston

(sample 9). No foraminiferans were found in sample 23, near George Town. Of the 104 species recorded only 4 (*Miliammina fusca*, *Ammonia aoteanus*, *Quinqueloculina poeyanum* and *Q. seminulum*) had a widespread distribution - the first two species present in all zones and the two *Quinqueloculina* spp. in all but the upper Tamar Zone.

There was a marked change in the faunas along the estuary and this has enabled four faunal assemblages to be recognized (fig. 2).

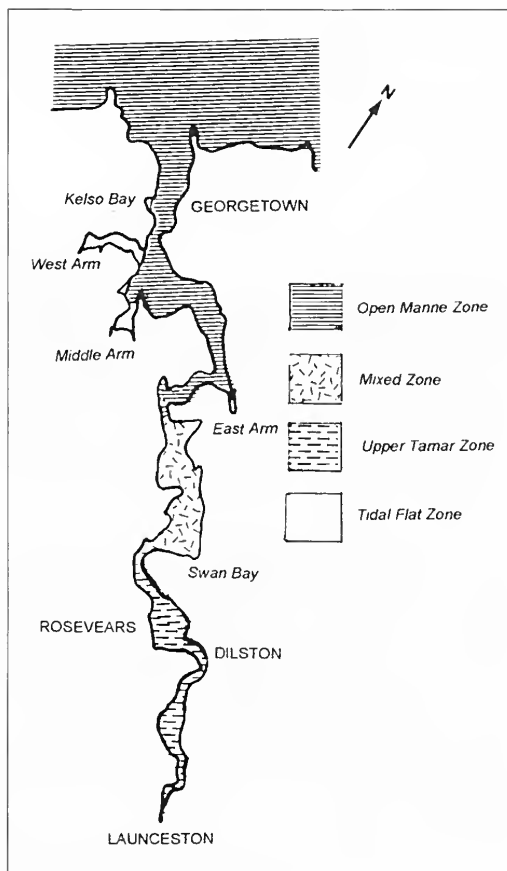


Fig. 2  
Foraminiferal zonation of the Tamar estuary and Port Dalrymple.

### Open Marine Zone (Samples 1-8, 19, 27, 30, 31, 33, 34)

The sediments in this northernmost zone were all clean sands with varying amounts of sea grasses. These samples contained a large and varied fauna (98 spp) typical of other open marine beaches and estuaries in Victoria and NSW (Albani 1968, 1978, 1979; Collins 1974). The dominant genus was *Elphidium*, represented by 13 species of which, although huge numbers of well

preserved dead specimens occurred, only rare live ones were found. No planktic species were present. *Quinqueloculina* spp were mainly restricted to the northernmost part of this zone with only the more low oxygen tolerant *Q. poeyanum* and *Q. seminulum* occurring in the southerly part of this zone. The lagenid species, usually represented by small numbers of specimens per species per sample, were also found mainly in the more northerly samples. It is possible that this zone could be subdivided into northern and southern parts at about Beaconsfield when more data become available.

### Mixed Zone (Samples 11-18, 22)

Between Rowella and Swan Bay the faunas showed a mixture of species between the open marine zone and the Upper Tamar zone. Species numbers were lower (12-20) than in the open marine zone and the presence of occasional *Miliammina fusca*, *Trochammina inflata* and *Reophax barwonensis* show that at times low oxygen content water must reach this area but in insufficient quantity to stop the more tolerant ocean fauna from existing there. *Rotalia perlucida* is the only species restricted to this zone. It is notable that *Elphidium* spp are rare in this zone with only *E. macellum* occurring in one sample; this is in great contrast to the open ocean zone.

### Tidal Flat Zone (Samples 24-26, 28, 29, 32, 35)

Samples from East Arm, West Arm, Middle Arm and Kelso Bay were from the intertidal zone and all had a similar fauna with *M. fusca*, *Ammonia aoteanus*, *Quinqueloculina seminulum* and *Hyantsina depressula* dominant. This zone differs from the upper Tamar zone in the presence of *Elphidium* spp, the larger numbers of specimens of all species and in that most species were found alive in large numbers.

### Upper Tamar Zone (Samples 9, 10, 20, 21)

South of Swan Bay the sediments consisted mainly of a black sandy mud grading further upstream at Windermere, Rosevears and Dilston to a black glutinous mud. Foraminiferans were uncommon and only rarely were any live specimens found - an exception was in sample 20 where *M. fusca* was very common and only live specimens were found.

Typical common species were *M. fusca*, *A. aoteanus* with rare specimens of *Haplophragmoides pusillus*, *Leptohalysis collinsi* n. sp., *R. barwonensis* and *Q. seminulum*. Dead tests of the calcareous species were rare although agglutinate tests were common.

South of Swan Bay dead tests of the calcareous species were uncommon to rare indicating acidic conditions existing at present. In this region the few living specimens of *A. aoteanus* were small, which further indicates stress conditions (Seiglie 1975).

## Discussion

The foraminiferan fauna of the River Tamar and Port Dalrymple has been found to be greatly affected by apparent pollution or lack of water flushing during tidal cycles. Based on the samples studied the tidal flushing, and so the introduction of oxygenated marine waters, only extends consistently to just south of Batman Bridge where between samples 19 and 16 the fauna changes markedly from 15 to 4 spp over a distance of approximately 0.5 km. Further south for about 10 km there is a mixed zone in which during some tidal cycles (possibly neap and king tides) the marine waters are refreshed sufficiently to enable some of the more hardy (lower oxygen requirement) species to barely exist. However the tidal flushing is apparently not sufficient to enable most of the *Elphidium* species to exist south of about Beaconsfield as only one of the 13 species (*E. macellum*) is known alive in the mixed zone and none in the upper Tamar zone. In the mixed zone many specimens of *E. macellum* and *A. aoteanus* have deformed tests: the tests may be twisted or the chambers show various types of abnormal growth e.g. smaller chambers, pinched or lobate tests. Test deformation appears to be related to environmental stress, whether naturally occurring or man-made (Alve 1990; Yanko *et al.* 1994). In this section of the estuary the test deformations are most likely due to low or variable oxygen levels, but measurements of this parameter have yet to be made. For the remaining 40 km of the estuary fresh marine waters must seldom enter and the waters, being therefore low in oxygen, can support only a very restricted fauna. Finally near Launceston the sediments become evil smelling black muds which support no foraminiferan species at all.

That there has been a change of environmental factors in the River Tamar is shown by the presence near Launceston of a large and diverse molluscan fauna, of Late Holocene age (2600  $\pm$  400 years BP), representing marginal marine conditions, possibly tidal sand and mud flats (Goede *et al.* 1993). An inspection of the small quantity of sediment from this site held in the Queen Victoria Museum and Art Gallery produced no foraminiferans. The nearest similar living molluscan fauna (with the exception of *Anadara trapezia* which does not occur living in Tasmania) is now to be found some 40 km downstream from Launceston. Whether these changes to the faunas in the vicinity of Launceston are due to infilling of the Tamar estuary or man-made pollution effects is not known. It is known that foraminiferans are good indicators of sewage outfall, paper and pulp outfall and especially of heavy metal pollution (Alve 1991, and references therein; Seiglie 1975; Schafer *et al.* 1991; Sharifi *et al.* 1991). Whether the effects seen in the upper part of the River Tamar are due to sewage reducing the oxygen levels below the minimum needed for foraminiferan growth or to heavy metal input from past industrial processes, or a mixture of both, needs further work. It would be most instructive to obtain sediment cores in this section of the river for foraminiferal analysis to see if any anthropogenic pollution has occurred (Alve 1991).

## Taxonomic Notes

As most of the foraminiferans recorded from the River Tamar and Port Dalrymple are well known from other Australian waters (e.g. Albani 1968, 1970, 1978; Aphorpe 1980; Collins 1958, 1974; Parr 1932a, b; 1945, 1950; Yassini and Jones 1989, 1995) only selected interesting or unusual species are commented on here. A full species listing is given in Appendix 2.

## Genus *Hippocrepina* Parker 1870

*Hippocrepina* sp. cf. *H. flexibilis* (Wiesner 1931)

*Techinitella flexibilis* Wiesner, 1931: 85, pl. 7, fig. 75  
*Hippocrepina flexibilis* Parr, 1950: 258, pl. 3, fig. 20  
 Small pear-shaped specimens with a round terminal aperture are placed here. The wall is thin and composed of very small particles, smoothly finished. As with similar specimens from Mallacoota Inlet, Victoria (Bell and Drury, 1992), a few large grains of biotite are included in the test wall. The test was probably flexible in life as two specimens show a slight flattening near the apertural end. Parr (1950) recorded *H. flexibilis* from deep water off the Tasmanian coast. It may be that this shallow water *Hippocrepina* found at Port Dalrymple and also known from Mallacoota, Western Port and Queensland (pcrs. obs.) is a new species.

## Genus *Haplophragmoides* Cushman 1910

*Haplophragmoides pusillus* Collins 1974, pl. 1m

*Haplophragmoides pusillus* Collins 1974: 9, pl. 1, figs 2a-b  
 Typical specimens occurred in numerous samples. All were of smaller size than those from Port Phillip Bay (Collins, 1974) or Mallacoota Inlet (Bell and Drury, 1992) - the only two recorded localities for this species.

## Genus *Trochammina* Parker and Jones 1859

*Trochammina macrescans* Brady 1870

*Trochammina inflata* (Montagu) var. *macrescens* Brady 1870: 290, pl. 11, figs 5a-c

*Trochammina macrescens* Scott and Mediolì, 1980: 44, pl. 3, figs 1-8

This species has not apparently been previously reported in Australia, although it is well-known from North and South America (Scott *et al.* 1990) and Europe (Alvie, 1990). Dead specimens were found in samples 10 and 12, both in the middle reaches of the river. The specimens showed no supplementary apertures and such specimens are characteristic of areas with low salinities (Scott and Mediolì, 1980). Due to the degree of wear on these specimens it is most likely that they are part of the relict Holocene (?) fauna of the River Tamar.

## Genus *Leptohalysis* Loeblich and Tappan 1984

*Leptohalysis collinsi* n.sp. pls 2a-h

Description: Test small, elongate, slender, tapering; numerous chambers increasing in size, arranged linearly; chambers circular in section. Proloculum small, globular, then chambers become campanulate, initially as long as

broad but becoming longer than breadth (up to 1 1/2 times width) at the apertural end; each chamber tapering towards the oral end so that the oral end of each chamber is about half the width of the base of the chamber. Aperture simple, rounded, rarely with a small neck. Test wall finely arenaceous with rare larger grains embedded, smoothly finished. Colour pale brown. Flexible when wet.

Number of chambers: holotype 18 paratypes 9-15

Size: Holotype 1.5 mm long

Holotype: NMVF 74818; depth of 15 m, halfway between Crib Point and Stony Point, Western Port, Victoria; collected by Dr B.J. Smith and Miss Rhyllis Plant, Museum of Victoria collection, August 1970. Distribution: Specimens are known from Western Port, Victoria; Port Phillip Bay, Victoria. (Collins 1974 as *Reophax* sp.A), Mallacoota Inlet, Victoria. (Bell and Drury 1992 as *Leptohalysis* sp.); Clyde River estuary, Bateman's Bay, NSW (K. Cotter, in press); Port Dalrymple and the River Tamar, Tasmania; all of which are of shallow - intertidal depths. It is also known as a fossil from a Holocene sediment core from Corner Inlet, Victoria (Bell *et al.* 1995).

Remarks: This species belongs to the *R. scotti* group of Høglund (1947). Loeblich and Tappan (1984) erected the genus *Leptohalysis* to include these small, elongate, campanulate chambered, flexible forms. The species *collinsi* is close to *L. catella* (Høglund) described from the Skagerak and the Gullmar Fjord of Scandinavia; it differs in being smaller and more slender and in showing a different and more variable chamber shape than those figured by Høglund. Occasional very large individual chambers or chamber groups (1-3 chambers) up to three times the size of the normal chamber are found indicating that larger specimens did occur, but as yet they have not been found intact. The chambers range from rectangular to almost triangular even within the one test but they never become as elongated as in *L. catenata* (Høglund). The chambers are not compressed and so separate *collinsi* from *L. scotti* Caster. The different living environments also serve to separate Høglund's species (cold, deep water) from this new form (intertidal and warm shallow water).

Derivation of Name: This species is named after the late Arthur C. Collins, in appreciation of his long studies on Australian Recent foraminiferans and unstinted help and advice on many problems.

Location of types:

Holotype NMVF 74818

Paratype A NMVF 74819

Paratype B NMVF 74820, all from the type locality, Western Port, Victoria and lodged in the Collections of the Museum of Victoria, Melbourne, Victoria;

Paratype C QVM:22:11, River Tamar, sample 5, 8 metre depth, sandy mud, TAMAR 842482,

Paratype D QVM:22:12, River Tamar, sample 4, 3 metre depth, sand, TAMAR 838488, both lodged in the Collections of the Queen Victoria Museum and Art Gallery, Launceston, Tasmania.

### Genus *Reophax* Montfort 1808

*Reophax barwonensis* Collins 1974, pl. 1, a

*Reophax barwonensis* Collins 1974, p. 8, pl. 1, fig. 1  
Hayward and Hollis (1994) have placed *R. barwonensis* in synonymy with *R. moniliforme* Siddal as the exterior characteristics are very similar. This is not accepted here as there appear to be significant differences between the two species; *moniliforme* has a test formed of small, silt-sized particles and characteristically using sponge spicules (Haynes 1973; Heron-Allen and Earland 1913, 1932) whereas that of *barwonensis* is formed of medium to larger grains and has not been seen using sponge spicules as a test wall component; *moniliforme* is fragile and more often than not only broken specimens are to be found (Heron-Allen and Earland 1913) but *barwonensis* is quite robust and very seldom is found incomplete; environmentally they also differ - *moniliforme* is an open ocean shelf species (Haynes 1973; Heron-Allen and Earland 1913, 1932) but *barwonensis* occurs in both Australia and New Zealand in estuarine or well protected marine lagoonal facies (Bell and Drury 1992; Collins 1974; Hayward and Hollis 1994).

### *Reophax friabilis* Parr 1932

*Reophax friabilis* Parr, 1932: 3 pl. 1, figs 2a-b, text fig. 1a  
This large, robust species is widespread, although rare, in the open marine zone. All specimens are of the megalospheric generation.

### Genus *Eggerella* Cushman 1933

*Eggerella advena* (Cushman 1922) pl. 1g

*Vernemilina polystrophia* Heron-Allen and Earland 1913: 55, pl. 4, figs 3-5 (not figs 1-2)

*Vernemilina advena* Cushman, 1922: 7, pl. 9, figs 7-9

A single specimen, questionably alive, was present in sample 5. The specimen is tiny and sharply pointed initially, similar to Cushman and Moyer (1930, pl. 7, fig. 6) and similar to MacFadyen's (1932) figure but without the large aperture of that specimen; the aperture in the present specimen was a small arch near the junction of the last three chambers.

Parr (1950) reported this species from a deep water Tasmanian locality.

### Genus *Spiroloculina* d'Orb. 1826

*Spiroloculina aequa* Cushman 1932 pl. 3c

*Spiroloculina antillarum* d'Orb. var. *aequa* Cushman, 1932: 40, pl. 10, figs 4-5

*Spiroloculina aequa* Cushman and Todd, 1944: 59, pl. 8, figs 13-15

Rare specimens in the northernmost samples are referable to this species. It has seldom been recorded from Australia (Collins, 1974).

### Genus *Quinqueloculina* d'Orb. 1826

*Quinqueloculina moyensis* Collins 1953

*Quinqueloculina moyensis* Collins, 1953: 98, pl. 1, figs 1a-c

This small subquadrate species occurred in the open marine zone. Specimens had smooth chambers with only feeble striations near the aperture.

### Genus *Peneroplis* Montfort 1808

*Peneroplis pertusus* Forskål 1775 *Nantilus pertusus* Forskål 1775: 125, no 65

*Peneroplis pertusus* Brady, 1884: 204, pl. 13, figs 16-17

One fine specimen found in sample 7. This normally warm water form has been recorded from Victorian waters (Chapman, 1907) and the Victorian Pleistocene (Collins, 1953).

### Genus *Rugobolivina* Hayward 1990

*Rugobolivina pendens* (Collins 1974) pl. 2j

*Bolivina pendens* Collins, 1974: 24, pl. 1, figs 14a,b; Haywood and Brazier 1980: 111, pl. 1, fig. 11; pl. 2, figs 13-16; pl. 3, figs 5-6

Rare specimens were scattered throughout the open marine zone and the more seaward samples in the mixed zone. Collins described this species from Bass Strait and Lower Port Phillip Bay, Victoria and it has been reported from Eucla (W.A.) and the Pleistocene of Victoria (Hayward 1990). Specimens in samples 4 and 6 stained pink in the last 3-4 chambers with the other chambers being a yellowish-green and is thus considered to have been alive when collected; live specimens have not been reported previously (Haywood and Brazier, 1980, p. 114).

### Genus *Bolivina* Cushman 1927, emend. Hayward 1990

*Bolivina folium* (Parker and Jones 1865) pl. 2i

*Textularia folium* Parker and Jones 1865: 370, 420, pl. 18, fig. 19

*Bolivina folium* Parr, 1932a: 223, pl. 21, fig. 23

Specimens in sample 6 stained pink in the last few chambers with earlier chambers being colourless or yellow-green. It has not previously been reported live-taken (Haywood and Brazier, 1980, p. 114). No plastogamic pairs were found.

### Genus *Guttulina* d'Orb 1839

*Guttulina regina* (Brady, Parker and Jones 1870) pl. 3g

*Polymorphina regina* Brady, Parker and Jones, 1870: 241, pl. 41, figs 32a-b; Chapman 1907: 132, pl. 10, fig. 4  
*Guttulina regina* (Brady, Parker and Jones) Cushman and Ozawa 1930: 34, pl. 6, figs 1-2; Parr and Collins 1937: 193, pl. 12, fig. 5, text figs 1-7

This species was present in most of the open marine samples. The degree and strength of the striations on the test varied, with occasional specimens having very weak or no striations.

**Genus Elongobula Finlay 1939***Elongobula gracilis* (Collins 1953) pl. 3j*Buliniuella gracilis* Collins 1953: 102, pl. 1, figs 8a-b; Albani 1968: 106, pl. 8, fig. 9*Buliniuoides gracilis* (Collins) Seiglie 1970: 112; Collins 1974: 29

Originally described from the Victorian Pleistocene, it has since been found widespread in southern Australian shallow waters (Collins 1974; Albani 1968). Revets (1993) has placed this species in *Elongobula* as specimens possess a tooth plate and have a different apertural face to *Buliniuoides*.

**Genus Bolivina d'Orb. 1839***Bolivina pseudoplicata* Heron-Allen and Earland 1930 pl. 5a*Bolivina pseudoplicata* Heron-Allen and Earland 1930: 81, pl. 3, figs 36-40

A very common species in this collection. The degree of development of the ridges on the test is variable - some specimens being heavily rugose. Haynes (1973) has suggested that this species has a north-west Atlantic distribution only but it has been reported from many Southern Australian localities (Apthorpe 1980; Bell and Drury 1992; Collins 1974; Parr 1945; Yassini and Jones 1989).

**Genus Hopkinsina Howe and Wallace 1932***Hopkinsina victoriensis* Collins 1974

*Hopkinsina victoriensis* Collins 1974: 34, pl. 2, figs 23a-b  
A single specimen of this Port Phillip Bay species was found in sample 5. It differed slightly in that the longitudinal costae tended to be more pronounced.

**Genus Pileolina Bermudez 1952***Pileolina* sp. aff. *P. opercularis* (d'Orb. 1826)*Rosalina opercularis* d'Orb. 1826: 271, no. 7*Discorbiina opercularis* Brady 1884: 650, pl. 89, figs 8-9*Conorbella opercularis* Bermudez, 1952: 37*Pileolina* (?) *opercularis* Barker 1960: 184

This a thin, low domed discorbid-like species with highly arcuate chambers. Two specimens in sample 6 are similar to those figured by Brady (1884), who recorded it from Raine Island, Torres Strait; East Monocur Island, Bass Strait; Port Jackson, NSW and Curtis Strait, Queensland. Other Australian records are Great Barrier Reef (Collins 1958), Torquay (Chapman 1907), deep water off Tasmania (Parr 1950) and Hardy Inlet, Western Australia (Quilty 1977).

Bermudez (1952: 37) suggested that the specimens figured by Brady are not of d'Orbigny's species and Barker (1960) placed it in *Pileolina* with the suggestion that it is a new species.

The present specimens differ from d'Orbigny's redescription of the type (d'Orbigny 1839) in size (1 1/2-2 whorls in 0.4 mm compared to the type with 3 whorls in .25 mm), in the ventral surface being pustular not striated, apparently being much flatter and in having more arcuate chambers. Until more material becomes available it is here recorded under d'Orbigny's name.

**Genus Pseudohelina Collins 1974***Pseudohelina collinsi* (Parr 1932)*Discorbis collinsi* Parr 1932: 230, pl. 22, figs 33a-c*Pseudohelina collinsi* Collins 1974: 37, pl. 2, figs 26 a-c

Not uncommon in sample 5. Specimens usually showed the supplementary apertures on only the last 2-3 chambers.

**Genus Ammonia Brunnich 1772***Ammonia aoteanus* (Finlay 1940)*Strebulus aoteanus* Finlay 1940, p. 461*Ammonia aoteanus* Hedley, Hurdle and Burdett 1967, p. 47, pl. 11, figs 4a-c, text figs 56-60*Ammonia beccarii* forma *aoteanus* Haywood and Hollis, 1994, p. 213, pl. 4, figs 1-3

Remarks: This species was present in all zones and in almost all samples. It was present in largest numbers in the open marine and mixed zones becoming very rare by the upper Tamar zone; specimens from the upper reaches of the river were smaller and had less umbilical filling than the more seaward specimens.

In Victoria this species has been referred to *A. aoteanus* (Apthorpe 1980, Collins 1974) whilst Parr (1945), although calling it *A. beccarii* (Linné), noted that it was not the typical Mediterranean form but was identical to specimens from Scotland. Apthorpe (1980) proposed that it is a cool temperature morphotype of *beccarii*.

The identification of species, subspecies and formae within the plexus of *A. beccarii* has been long debated. In a study of laboratory cultures of *A. beccarii*, Schnitker (1974) found a wide morphological variation displayed and suggested that only one species was valid and that other 'species' should be regarded as ecophenotypes. Walton and Sloan (1990) in a comprehensive review of the genus *Ammonia* recognized three morphotypes of *beccarii* - forma *tepida*, forma *parkinsoniana* and forma *beccarii*, with f. *tepida* and f. *parkinsoniana* as ecophenotypes and constituting the two end members of a gradational series. Haywood and Hollis (1994) in discussing the New Zealand forms of *beccarii* distinguished two distinct formae: *tepida* and *aoteana*. They found that both formae often occurred together and that intermediates between these two formae were common. They commented that whilst *parkinsoniana* and *aoteana* are similar *aoteanus* often differs in lacking umbilical filling and in sutural shape. Poag (1978), Billman *et al.* (1980) and Jorissen (1988) have questioned whether *parkinsoniana* should not be considered a true species distinct from *beccarii*, with *beccarii* dominant in the Mediterranean and *parkinsoniana* dominant in the western Atlantic and adjacent seas.

Although some studies (Chang and Kacsler 1974; Jorissen 1988) have suggested that the morphological variations found in *beccarii* may be ecologically controlled, Malmgren (1984) found that in southern European waters the morphotypes present did not show any relation to environmental variables (salinity, temperature, pH, oxygen levels).



The different formae of *beccarii* have been separated on the ornamental features present (presence or absence of umbilical plugs, bosses and granular sutural beading) but a study of the internal structure of ornamental (*beccarii*) and smooth (*tepida*) forms showed that no differences existed (Levy *et al.* 1986).

The presence of ecophenotypes in foraminifera has been questioned in a well reasoned argument by Haynes (1992) who has cast doubts on Schnitker's methodology and subsequent inferences (Schnitker 1974), and has suggested other explanations for the morphological variations found.

Until adequate comparative biometric and cultural studies are carried out to determine the relationship between this common form in Tasmanian and Victorian waters and the other described formae of *beccarii* (or *parkinsoniana*) I prefer to record it as *A. aoteanus*.

### Genus *Elphidium* Montfort 1808

*Elphidium argenteum* Parr 1945 pl. 4i

*Elphidium argenteum* Parr 1945, p. 216, pl. 12, fig. 7a, b  
By extending the definition of *E. advenum* Cushman, Hayward and Hollis (1994) placed *argenteum* in synonymy. However *E. advenum* has a smooth, translucent exterior surface (Cushman 1939) whereas in *argenteum* the surface is closely beaded with fine tubercles which Parr suggested gave the silvery appearance to the test. Although it may be a variety of *E. advenum* it is here listed as a separate species on the basis of the wall surface.

### *Elphidium jenseni* (Cushman 1924) pl. 4a

*Polystomella macella* (Fitchel and Moll) var. *Jensen* 1904: 817, pl. 23, fig. 4

*Polystomella jenseni* Cushman 1924: 49, pl. 16, figs 4, 6  
*Elphidium jenseni* Albani, 1968: 112, pl. 10, fig. 8

Very common in the open marine zone, with many live specimens. Jensen (1904) figured a specimen from 100 fathoms off NSW and Albani (1964) reported it from Port Hacking, NSW but all other records are from shallow tropical waters (Samoa, Fiji and several other south Pacific sites). It is interesting to note that it has not been recorded from Victoria.

### *Elphidium limbatum* (Chapman 1907) pl. 4e

*Polystomella macella* (Fitchel and Moll) var. *limbata* Chapman. 1907: 142 pl. 10, figs 9a-b

*Elphidium limbatum* Collins 1974: 41

Specimens were restricted to the open marine fauna. It is easily identified by the clear inflated walls on the anterior part of the chambers.

### *Elphidium macellum* (Fichtel and Moll) pl. 4b

*Nautilus macellus* Fichtel and Moll. 1798: 66, pl. 10, figs h-k

*Elphidium macellum* Collins, 1974: 42

Included in here are forms both with and without peripheral spines. Many of the present specimens showed only one or two small stumpy spines and as it has been shown that juveniles of *E. macellum* are often spinose but that mature specimens of spinose juveniles may be non-spinose (Haynes 1973) the variety *aculeatum* is not separated here.

### Genus *Haynesina* Banner & Culver 1978

*Haynesina depressula* (Walker and Jacob 1798) pl. 4f

*Nautilus depressulus* Walker & Jacob 1798, p. 641, fig. 33  
*Haynesina depressula* (Walker & Jacob) Hayward and Hollis, 1994, 216, pl. 5, figs 13-16

Previously reported widely in Australia as *Elphidium simplex* Cushman. It was seldom found in the most open marine zone and is more characteristic of the fauna found on sandy tidal flat areas.

### Genus *Notorotalia* Finlay 1939

*Notorotalia clathrata* (Brady 1884) pl. 4j

*Rotalia clathrata* Brady 1884: 709, pl. 107, fig. 8

*Notorotalia clathrata* Finlay, 1939: 517; Collins, 1974: 44  
Samples 6 and 7 contained rare specimens of this species which was described originally from Bass Strait. Some specimens in sample 7 were not as reticulate as specimens from elsewhere and were less convex, almost planar, ventrally. No aperture could be distinguished on any specimens.

Parr (1939) has recorded this species from the Victorian Pliocene.

### Genus *Glabratella* Dorreen 1948

*Glabratella patelliformis* (Brady 1884)

*Discorbina patelliformis* Brady 1884: 647, pl. 89, figs 1a-c  
*Glabratella patelliformis* Albani 1968: 110, pl. 9, figs 11, 15  
Specimens from the deeper water samples were mainly single whereas those from the shallows and intertidal samples were mostly plastogamic pairs, usually with a great disparity in the sizes of the joined specimens.

### Genus *Cibicides* Montfort 1808

*Cibicides lobatulus* (Walker and Jacob) pl. 3o

*Nautilus lobatulus* Walker and Jacob 1798: 39, pl. 12, fig. 36  
*Cibicides lobatulus* Cushman, 1918 (1931): 118, pl. 21, fig. 3

Specimens were widespread in the open marine zone. The placement here of some specimens is difficult; smaller specimens only showed perforations on the last 2-3 chambers on the dorsal side and had a planar-convex shape with no lobation of the latter chambers. In this respect they resemble *C. pseudonigerianus* Cushman and the Victorian Miocene *C. mediocris* Finlay.

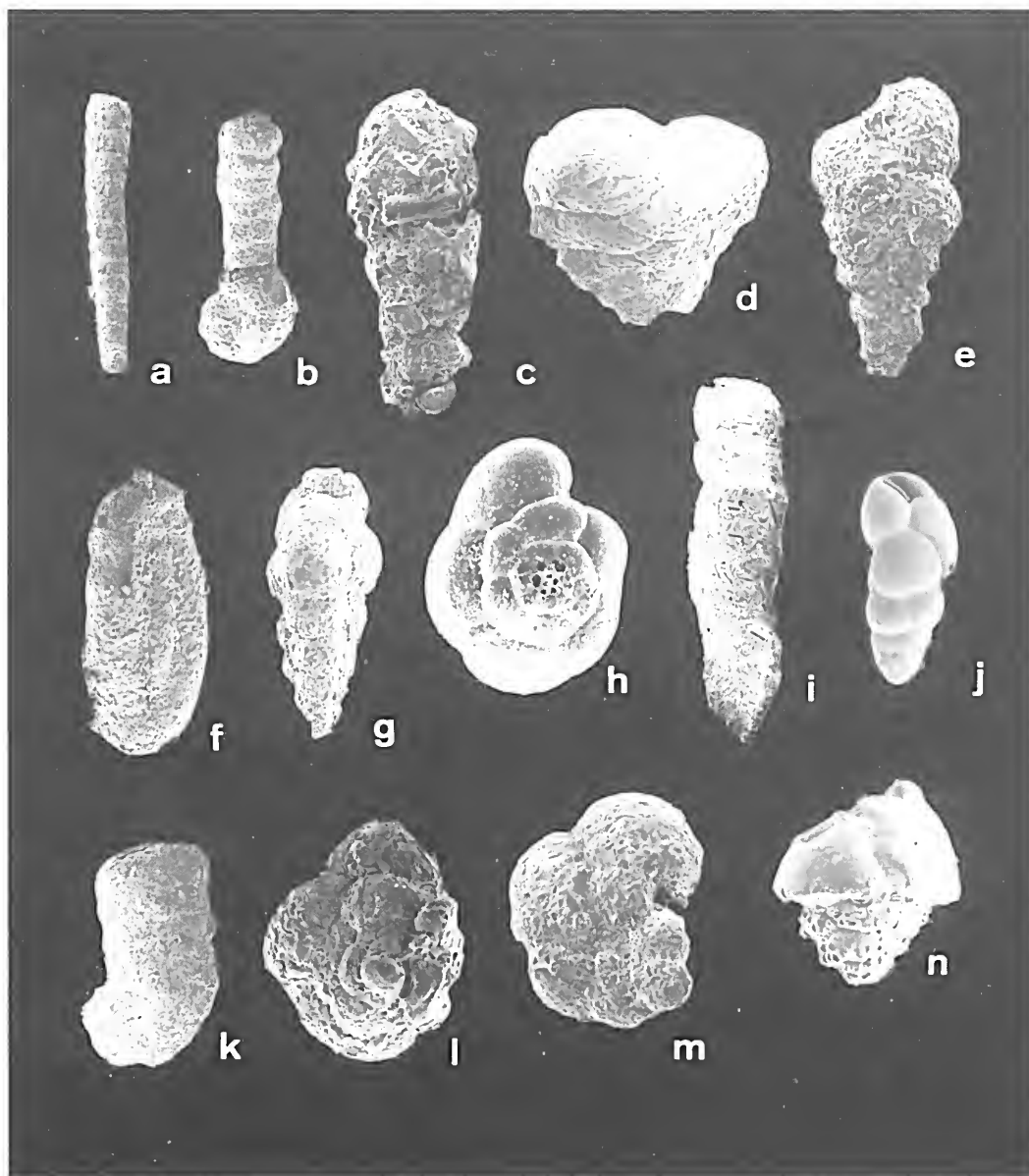


Plate 1

- a *Reophax barvouensis* Collins, QVM:22:2099, x54
- b *Ammobacculites exiguus* Cushman and Bronnimann, QVM:22:2100, x60
- c *Warrenita palustris* (Warren), QVM:22:2101, x240
- d *Sahulia conica* (d'Orb.), QVM:22:2102, x90
- e *Textularia earlandi* Parker, QVM:22:2103, 180
- f *Miliammina fusca* (Brady), QVM:22:2104, x90
- g *Eggerella advena* Cushman, QVM:22:2105, x180
- h *Trochammina inflata* (Montagu), QVM:22:2106, x60
- i *Clavulina multicaerata* Chapman, QVM:22:2107, x36
- j *Bulinina gibba* (Fornasini), QVM:22:2108, x150
- k *Ammobacculites barvouensis* Collins, QVM:22:2109, x60
- l *Trochammina sorosa* Parr, spiral side, QVM:22:2110, x130
- m *Haplophragmoides pusillus* Collins, QVM:22:2111, x180
- n *Bulinina marginata* d'Orb, QVM:22:2112, x150

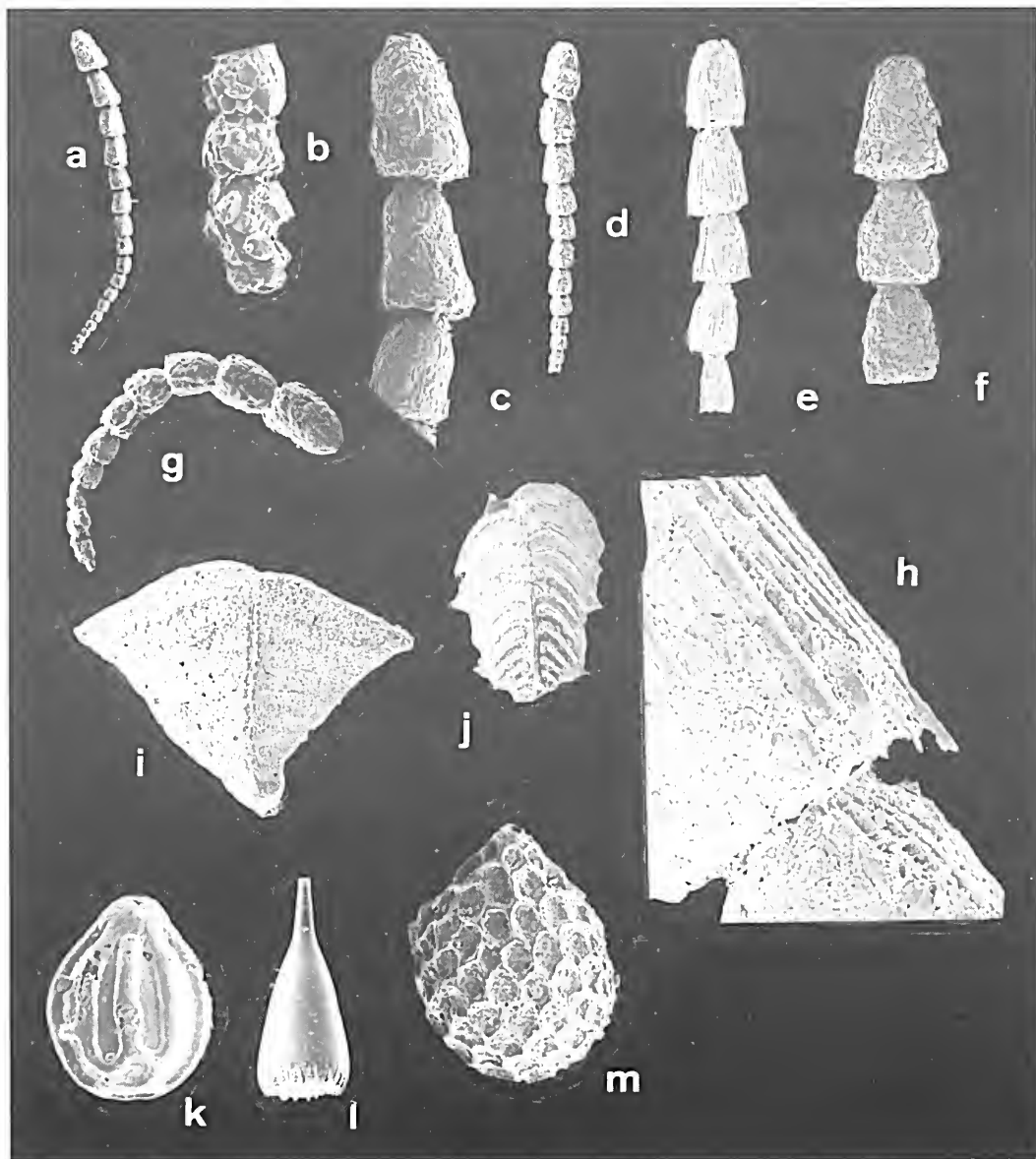


Plate 2

a-h *Leptohalysis collinsi* Bell n.sp.

- a Holotype, NMV F74818, x33
- b Holotype proloculum and early chambers, x300
- c Holotype, apertural chambers, x120
- d Paratype, NMV F74819, x50
- e Paratype, QVM:22:11, x75
- f Paratype, NMV F74820, x120
- g Paratype, QVM:22:12, x72
- h Enlargement of Paratype, QVM:22:11, showing parallel sponge spicules in wall, x480
- i *Bolivinella foliina* (Parker and Jones), QVM:22:2113, x120
- j *Rugobolivinella pendens* Collins, QVM:22:2114, x80
- k *Oolina ramulosa* (Chapman), QVM:22:2115, x120
- l *Lagena crenata* (Parker and Jones), QVM:22:2116, x90
- m *Favulina hexagona* (Williamson), QVM:22:2117, x130

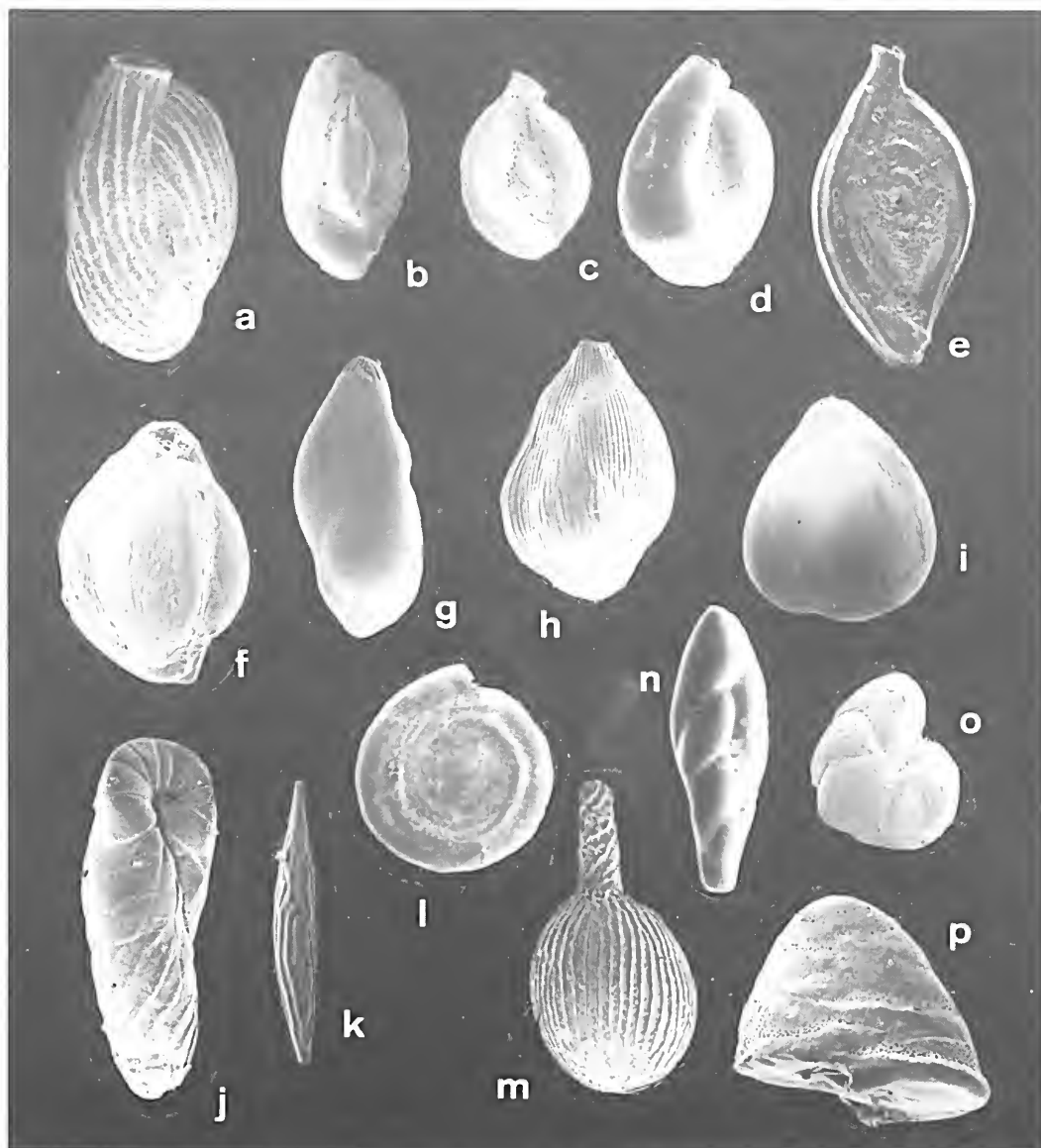


Plate 3

- a *Quinqueloculina poeyanum* (d'Orb.), QVM:22:2118, x120
- b *Quinqueloculina subpolygona* Parr., QVM:22:2119, x60
- c *Sigmoilina aequa* Cushman, QVM:22:2120, x60
- d *Quinqueloculina seminulum* (Linne), QVM:22:2121, x60
- e *Spiroloculina antillarum* d'Orb., QVM:22:2122, x90
- f *Triloculina trigonula* (Lamarek), QVM:22:2123, x110
- g *Gutulina regina* (Brady, Parker & Jones), QVM:22:2124, x70
- h *Gutulina yabei* Cushman & Ozawa, QVM:22:2125, x100
- i *Gutulina silvestrii* Cushman & Ozawa, QVM:22:2126, x90
- j *Elongobula gracilis* (Collins), QVM:22:2127, x130
- k *Procerolagena diastoma margaritifera* (Parker & Jones), QVM:22:2128, x40
- l *Spirillina vivipara* Ehrenberg, QVM:22:2129, x120
- m *Lagena* sp. cf. *L. sulcata* (Walker & Jacob), QVM:22:2130, x150
- n *Fursenkoina schrieberiana* (Czjzek), QVM:22:2131, x72;
- o *Cibicides lobatulus* (Walker & Jacob), QVM:22:2132, x150;
- p *Potellinella inconspicua* (Brady), QVM:22:2133, x120.

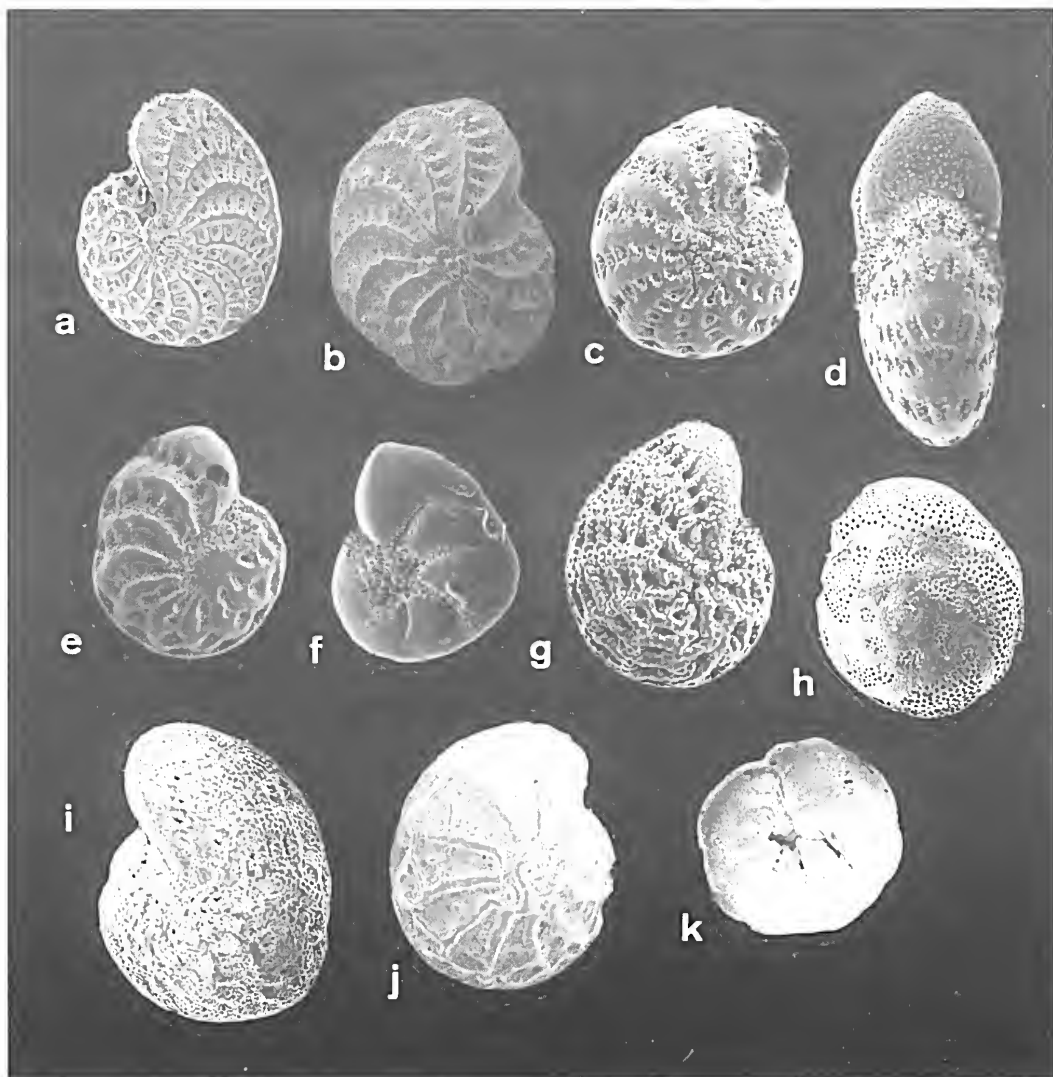
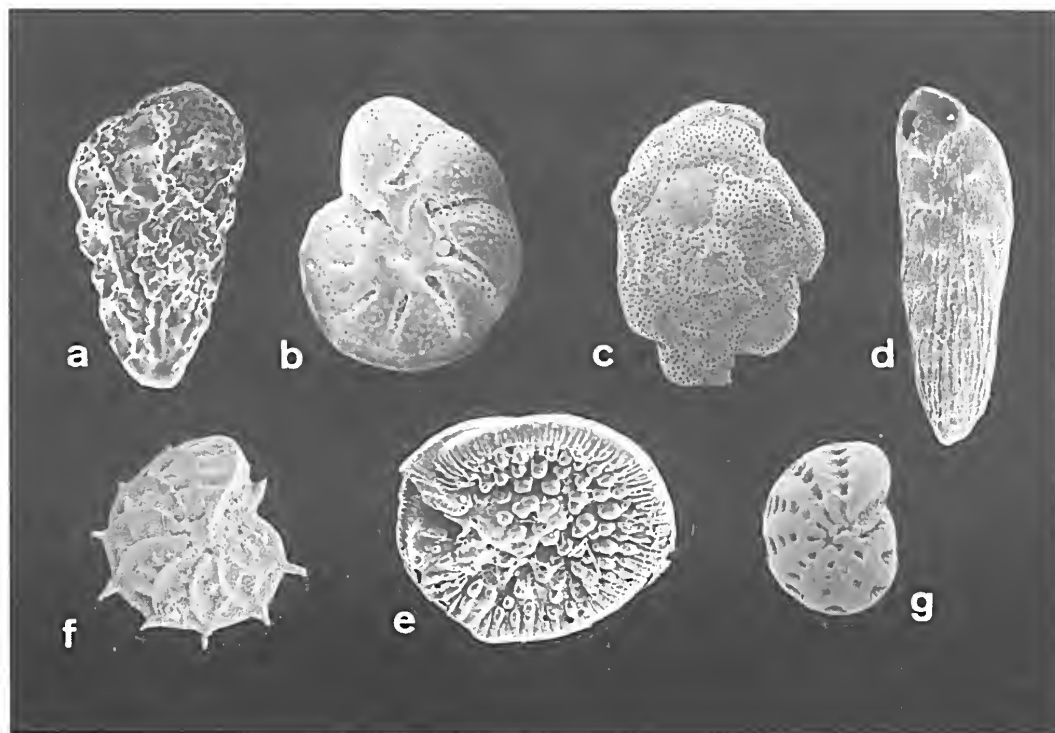


Plate 4

- a *Elphidium jeuseni* (Cushman), QVM:22:2134, x100
- b *Elphidium macellum* (Fitchel & Moll), QVM:22:2135, x90
- c *Elphidium gunteri corioensis* Collins, QVM:22:2136, x120
- d *E. gunteri corioensis*, edge view, QVM:22:2137, x160
- e *Elphidium limbatum* Chapman, QVM:22:2138, x120
- f *Haynesina depressula* (Walker & Jacob), QVM:22:2139, x120
- g *Elphidium granulatum* Collins, QVM:22:2140, x150
- h *Rosalina australis* (Parr), h. dorsal side, QVM:22:2141, x90
- i *Elphidium argenteum* Parr, QVM:22:2142, x110
- j *Notorotalia clathrata* (Brady), QVM:22:2143, x120
- k *Rosalina australis* (Parr) ventral side, QVM:22:2144, x80



**Plate 5**

- a *Brizalina pseudoplicata* Heron-Allen & Earland, QVM:22:2145, x120
- b *Laumellodiscorbis dimidiatus* (Parker & Jones), QVM:22:2146, x72
- c *Acervulina inadhereus* (Schultze), QVM:22:2147, x90
- d *Bolivina striatula* Cushman, QVM:22:2148, x120
- e *Rosalina parri* Collins, ventral view, QVM:22:2149, x160
- f *Elphidium macellum* (Fichtel & Moll), QVM:22:2150, x120
- g *Elphidium excavatum* (Terquem), QVM:22:2151, x120

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## Appendix 1

Locality data: All grid references refer to Tasmanian Lands Department Tamar Region 1:100000 Topographic map.

1	GR 825504	3 m	sand, weed
2	830489	1.5 m	sand
3	833495	2 m	sand
4	838488	3 m	sand
5	842482	8 m	sandy mud
6	822510	intertidal	sand, weed
7	824505	intertidal	sand, weed
8	826499	intertidal	sandy mud
9	098140	0.5 m	black mud
10	017238	5 m	mud
11	979382	10 m	black mud
12	982381	15 m	black mud
13	984381	3 m	muddy, fine silt
14	989288	2 m	muddy sand with weed
15	980390	4 m	muddy sand with weed
16	945350	3 m	silty mud
17	946343	5 m	silty mud
18	952334	5 m	silty mud
19	944355	4 m	dark brown mud
20	043238	3 m	brown mud
21	997259	2 m	black mud
22	975345	intertidal	brown mud
23	846488	intertidal	sand
24	823485	intertidal	sandy grit with weed
25	824485	intertidal	sandy mud
26	822486	intertidal	yellow clay
27	842471	intertidal	muddy sand
28	807430	intertidal	mud-gravel
29	805425	intertidal	muddy sand
30	846449	intertidal	muddy sand
31	852435	1 m	sandy grit
32	968395	intertidal	brown mud
33	842508	intertidal	sand, weed
34	838507	intertidal	sand, weed
35	874404	intertidal	brown mud

## Appendix 2

Species identified from Port Dalrymple and the River Tamar. For each species the original citation is given as well as, where possible, a more recent reference in which a fuller synonymy and/or illustration can be found.

### *Hippocrepina* sp.cf. *H. flexibilis* (Wiesner 1931)

*Technitella flexibilis* Wiesner 1931: 85, pl. 7, fig. 75

*Hippocrepina flexibilis* Parr 1950: 258, pl. 3, fig. 20

### *Miliammina fusca* (Brady 1870)

*Quinqueloculina fusca* Brady 1870: 286, pl. 11, figs 2a-e

*Miliammina fusca* Collins 1974: 9

### *Leptohalysis collinsi* n.sp.

*Leptohalysis collinsi* n.sp.

### *Reophax harwaucensis* Collins 1974

*Reophax barwonensis* Collins 1974: 8 pl. 1, fig. 1.

### *Reophax friabilis* Parr 1932

*Reophax friabilis* Parr 1932: 3, text fig. 1a, pl. 1, figs 2a-b

### *Warreuita palustris* (Warren 1957)

*Sulcophax palustris* Warren 1957: 31, pl. 3, figs 1-4

*Warreuita palustris* Loeblich & Tappan 1984: 1160

### *Amuobaculites?* *barwoncusis* Collins 1974

*Amuobaculites?* *barwonensis* Collins 1974: 9, pl. 1, figs 3a-b

### *Amuobaculites exiguus* Cushman & Bronniman 1948

*Amuobaculites exiguus* Cushman and Bronniman 1948: 38, pl. 7, figs. 7-8; Hedley, Hurdle & Burdett 1967: 19, pl. 5, figs 5a-b

### *Haplaphragmoides pusillus* Collins 1974

*Haplaphragmoides pusillus* Collins 1974

### *Textularia carlandi* Parker 1952

*Textularia tenuissima* Earland 1933: 95, pl. 3, figs 21-30

*Textularia earlandi* Parker 1952: 458

### *Sahulia couica* (d'Orbigny 1839)

*Textularia couica* d'Orb. 1839: 143, pl. 1, figs 19,20

*Sahulia couica* Loeblich & Tappan 1985: 205

### *Trochammina inflata* (Montagu 1808)

*Nautilus inflatus* Montagu 1808: 81, pl. 18, fig. 3

*Trochammina inflata* Albani 1968: 96, pl. 7, figs 3-5

### *Trachammina macrescens* Brady 1870

*Trochammina inflata* (Montagu) var *macrescens*

Brady 1870: 290, pl. 11, figs 5a-c

*Trochammina macrescens* Scott and Mediolini, 1980: 44, pl. 3, figs 1-8

### *Trochammina sorosa* Parr 1950

*Trochammina sorosa* Parr 1950: 278, pl. 5, figs 15-17

### *Eggerella subcouica* Parr 1950

*Eggerella subconica* Parr 1950: 281, pl. 5, figs 22a,b

### *Eggerella advena* (Cushman 1921)

*Verneuilina advena* Cushman 1921: 9

*Eggerella advena* Cushman 1937: 51, pl. 5, figs 12-15

- Clavulina multicamerata* Chapman 1907  
*Clavulina parisienensis* d'Orbigny var. *multicamerata* Chapman 1907: 127, pl. 60, fig. 5  
*Clavulina multicamerata* Parr 1932: 4, pl. 1, figs 4-5
- Spiroloculina aequa* Cushman 1932  
*Spiroloculina antillarum* d'Orbigny var. *aequa* Cushman 1932: 40, pl. 10, figs 4-5  
*Spiroloculina aequa* Cushman & Todd 1944: 59, pl. 8, figs 13-15
- Spiroloculina antillarum* d'Orbigny 1839  
*Spiroloculina antillarum* d'Orb. 1839: 166, pl. 9, figs 3-4; Parr 1932: 9, pl. 1, fig. 11
- Quinqueloculina milletti* (Wiesner 1912)  
*Quinqueloculina milletti* Wiesner 1912: 220; Collins 1958: 360
- Quinqueloculina moyuensis* Collins 1953  
*Quinqueloculina moyuensis* Collins 1953: 98, pl. 1, figs 1a-c
- Quinqueloculina seminulum* (Linné 1767)  
*Serpula seminulum* Linné 1767: 1264, no. 791  
*Miliolina seminulum* Brady 1884: 157, pl. 5, figs 6a-c
- Quinqueloculina subpolygona* Parr 1945  
*Quinqueloculina subpolygona* Parr 1945: 196, pl. 12, figs 2a-c; Albani, 1968: 99 pl. 7, figs 12-14
- Quinqueloculina poeyana* (d'Orbigny 1839)  
*Quinqueloculina poeyana* d'Orb. 1839: 191, pl. 11, figs 25-27; Parker, Phleger and Peirson 1953: 12, pl. 2, figs 13-14
- Sigmoilina australis* (Parr 1932)  
*Quinqueloculina australis* Parr 1932: 7, pl. 1, figs 8a-c
- Triloculina trigounula* (Lamarck 1804)  
*Miliolina trigounula* Lamarck 1804: 351, No. 3  
*Triloculina trigounula* Cushman 1932: 56, pl. 13, figs 1a,b
- Triloculina sabulosa* Collins 1974  
*Triloculina sabulosa* Collins 1974: 18, pl. 1, figs 7a-c
- Triloculina oblonga* (Montagu 1803)  
*Verruculum oblongum* Montagu 1803: 522, pl. 14, fig. 9  
*Triloculina oblonga* Parr 1932: 10, pl. 1, figs 15a-c
- Miliolinella labiosa* (d'Orbigny 1839)  
*Triloculina labiosa* d'Orb. 1839: 178, pl. 10, figs 12-14; Parr 1932: 220, pl. 22, fig. 44
- Miliolinella oceanica* (Cushman 1932)  
*Triloculina oceanica* Cushman 1932: 54, pl. 12, fig. 3  
*Quinqueloculina baragwanathi* Parr 1945: 196, pl. 8, figs. 6a-c, pl. 12, fig. 3  
*Miliolinella oceanica* Ponder 1974: 133, pl. 4, figs. 1-5, pl. 5, figs 1-11
- Peueroplis pertusus* (Forskål 1775)  
*Nautilus pertusus* Forskål 1775: 125, no. 65  
*Peueroplis pertusus* Brady 1884: 204, pl. 13, figs 16-17
- Lagena crenata* Parker & Jones 1865  
*Lagena crenata* Parker and Jones 1865: 420, pl. 18, figs 4a-b; Brady 1884: 467, pl. 107, figs 15, 21
- Lagena nepeanensis* Collins 1974  
*Lagena nepeanensis* Collins 1974: 22, pl. 1, fig. 12
- Lagena parri* Loeblich and Tappan 1953  
*Lagena parri* Loeblich and Tappan 1953: 64, pl. 11, figs 11-13
- Lagena stelligera* Brady 1881  
*Lagena stelligera* Brady 1881: 60; Brady 1884: 466, pl. 57, figs 35-36
- Lagena striata strumosa* Reuss 1858  
*Lagena striata strumosa* Reuss 1858: 434; Albani and Yassini 1989: 380, fig. 2u
- Lagena sulcata* Walker and Jacob 1798  
*Lagena sulcata* Walker and Jacob 1798: 634, pl. 14, fig. 5; Brady 1884: 462, pl. 107, figs 23, 26, 33-34
- Favulina hexagona* (Williamson 1848)  
*Entosolenia squamosa* (Montagu) var. *hexagona* Williamson 1848: 20, pl. 2, fig. 23  
*Oolina hexagona* Albani and Yassini 1989: 386, fig. 3n
- Oolina globosa* (Montagu 1803)  
*Verruculum globosum* Montagu 1803: 235.  
*Oolina globosa* Albani and Yassini 1989: 386, figs 3p q
- Oolina melo* d'Orbigny 1839  
*Oolina melo* d'Orb. 1839: 20, pl. 5, fig. 9; Albani and Yassini 1989: 387, fig. 4a
- Oolina lineata* (Williamson 1848)  
*Entosolenia lineata* Williamson 1848: 18, pl. 2, fig. 18  
*Oolina lineata* Albani and Yassini 1989: 387, figs 4c, d
- Oolina ramulosa* (Chapman 1907)  
*Lagena acuticosta* Reuss var. *ramulosa* Chapman 1907: 129, pl. 9, fig. 9  
*Oolina ramulosa* Albani and Yassini 1989: 389, figs 4r, s
- Fissurina furcata* Collins 1974  
*Fissurina furcata* Collins 1974: 28, pl. 2, figs 18a-b
- Fissurina lacunata* (Burrows and Holland 1895)  
*Lagena lacunata* Burrows and Holland in Jones 1895: 205, pl. 1, figs 12a-b  
*Fissurina lacunata* Albani 1968: 105, pl. 8, fig. 16
- Palliolatella bradyiformis* (McCulloch 1977)  
*Fissurina bradyiformis* McCulloch 1977: 54, pl. 61, fig. 14  
*Palliolatella bradyiformis* Albani and Yassini 1989: 394, figs 5d, e
- Procerolagena distoma margaritifera* (Parker and Jones 1865)  
*Lagena distoma margaritifera* Parker and Jones 1865: 357, pl. 18, fig. 6  
*Procerolagena distoma margaritifera* Albani and Yassini 1989: 381, figs 3b, c
- Procerolagena elongata* (Ehrenberg 1843)  
*Miliola elongata* Ehrenberg 1843: 274, pl. 25, fig. 1  
*Procerolagena elongata* Albani and Yassini 1989: 383, fig. 3h

- Lentiuellina cultrata* (Montfort 1808)  
*Robulus cultrata* Montfort 1808: 214, fig. 54c  
*Cristellaria cultrata* Brady 1884: 550, pl. 70, figs 4-6
- Boliviella folium* (Parker and Jones 1865)  
*Textularia folium* Parker and Jones 1865: 370, 420, pl. 18, fig. 19  
*Boliviella folium* Hayward 1990: 48, pl. 1, figs 1-13; pl. 2, figs 1, 7; pl. 3, figs 2-3; pl. 4, figs 6-7; pl. 9, figs 9-16
- Rugoboliviella pendens* (Collins 1974)  
*Boliviella pendens* Collins 1974: 24, pl. 1, figs 14a-b  
*Rugoboliviella pendens* Hayward 1990: 72, pl. 8, figs 14-15; pl. 18, figs 13-17
- Guttulina regina* (Brady, Parker and Jones 1870)  
*Polymorphina regina* Brady, Parker and Jones 1870: 241, pl. 41, figs 32a-b  
*Guttulina regina* Albani 1968: 104, pl. 8, figs 14-15
- Guttulina silvestrii* Cushman and Ozawa 1930  
*Guttulina silvestrii* Cushman and Ozawa 1930: 51, pl. 37, figs 6-7; Parr and Collins 1937: 197, pl. 12, fig. 11
- Guttulina yabei* Cushman and Ozawa 1929  
*Guttulina yabei* Cushman and Ozawa 1929: 68, pl. 13, fig. 2; pl. 14, fig. 6; Parr and Collins 1937: 192, pl. 12, figs 3, 4a-c; (nou pl. 14, figs 4a-c)
- Sigmonomorphina williamsoni* (Terquem 1878)  
*Polymorphina williamsoni* Terquem 1878: 37  
*Sigmonomorphina williamsoni* Parr and Collins 1937: 205, pl. 15, fig. 5
- Elongobula gracilis* (Collins 1953)  
*Boliviella gracilis* Collins 1953: 102, pl. 1, figs 8a-b  
*Elongobula gracilis* Revets 1993: 256, pl. 2, figs 3-5
- Buliminoides elegantissima* (d'Orbigny 1839)  
*Bulimina elegantissima* d'Orb. 1839: 51, pl. 7, figs 13-14  
*Buliminoides elegantissima* Cushman and Parker 1947: 67, pl. 17, figs 10-12
- Bolivina pseudoplicata* Heron-Allen and Earland 1930  
*Bolivina pseudoplicata* Heron-Allen and Earland 1930: 81, pl. 3, figs 36-40; Apthorpe 1980, pl. 27, fig. 1
- Bolivina compacta* Sidebottom 1905  
*Bolivina robusta* Brady var. *compacta* Sidebottom 1905: 15, pl. 3, fig. 73  
*Bolivina compacta* Parr 1945: 206, pl. 9, fig. 8
- Brizalina striatula* (Cushman 1922)  
*Bolivina striatula* Cushman 1922: 27, pl. 3, fig. 10; Apthorpe 1980, pl. 27, fig. 2
- Brizalina spathulata* (Williamson 1858)  
*Textularia variabilis* var. *spathulata* Williamson 1858: 58, pl. 6, figs 164-165  
*Brizalina spathulata* Hedley, Hurdle and Burdett 1965: 21, pl. 6, figs 23a-b; text-figs 6a-g
- Rectobolivina raphanus* (Parker and Jones 1865)  
*Uvigerina raphanus* Parker and Jones 1865: 364, pl. 18, figs 16-17  
*Siphogenerina raphanus* Parr 1932: 225, pl. 21, fig. 24
- Sigmavirgulina tortuosa* (Brady 1881)  
*Bolivina tortuosa* Brady 1881: 57; Brady 1884: 420, pl. 52, figs 31-34
- Loxostomum limbatum* (Brady 1881)  
*Bolivina limbatum* Brady 1881: 57; Brady 1884: 419, pl. 52, figs 26-28
- Bulimina marginata* d'Orbigny  
*Bulimina marginata* d'Orb. 1826: 269, no. 4, pl. 12, figs 10-12; Apthorpe 1980, pl. 27, fig. 3
- Bulimina gibba* Fornasini 1902  
*Bulimina gibba* Fornasini 1902: 378, pl. O, figs 32-34; Albani 1968: 107, pl. 8, fig. 21
- Trifarina bradyi* Cushman 1923  
*Trifarina bradyi* Cushman 1923: 99, pl. 22, figs 3-9
- Hopkinsina victoriensis* Collins 1974  
*Hopkinsina victoriensis* Collins 1974: 34, pl. 2, figs 23a-b
- Angulodiscorbis quadrangularis* Uchio 1953  
*Angulodiscorbis quadrangularis* Uchio 1953: 156, pl. 7, figs 4a-c
- Glabratella patelliformis* (Brady 1884)  
*Discorbina patelliformis* Brady 1884: 674, pl. 89, figs 1a-c  
*Glabratella patelliformis* Albani 1968: 110, pl. 9, figs 11, 15
- Discorbinaella planocoueava* (Chapman, Parr & Collins 1932)  
*Planulina bicoueava* (Jones and Parker) var. *planocoueava* Chapman, Parr and Collins, ms in Parr 1932: 232, pl. 22, figs 34a-c  
*Discorbinaella planocoueava* Parr 1945: 211, pl. 11, figs 1-2
- Patellinella inconspicua* (Brady 1884)  
*Textularia inconspicua* Brady 1884: 357, pl. 42, figs 6a-c  
*Patellina inconspicua* Albani 1968: 108, pl. 8, figs 22-23
- Lamellodiscorbis dimidiatus* (Parker and Jones 1862)  
*Discorbina dimidiata* Parker and Jones 1862: 201, text-fig. 32b  
*Discorbis dimidiatus* Albani 1968: 108, pl. 8, figs 18, 24
- Pseudohelena collinsi* (Parr 1932)  
*Discorbis collinsi* Parr 1932: 230, pl. 22, figs 33a-c  
*Pseudohelena collinsi* Collins 1974: 37, pl. 2, figs 26a-c
- Spirillina denticulata* Brady 1884  
*Spirillina limbata* Brady var. *denticulata* Brady 1884: 632, pl. 85, fig. 17
- Spirillina vivipara* Ehrenberg 1843  
*Spirillina vivipara* Ehrenberg 1843: 442, pl. 3, fig. 41; Brady 1884: 630, pl. 85, figs 1-4
- Rosalina australis* (Parr 1932)  
*Discorbis australis* Parr 1932: 227, pl. 9, figs 15-16  
*Rosalina australis* Albani 1968: 109, pl. 9, fig. 8

***Rosalina anglica* (Cushman 1931)**

*Discorbis globularis* (d'Orb.) var. *anglica* Cushman 1931: 23, pl. 4, figs 10a-c

*Rosalina anglica* Albani 1968: 109, pl. 9, fig. 4

***Rosalina irregularis* (Rhumbler 1906)**

*Discorbina irregularis* Rhumbler 1906: 70, pl. 5, figs 57-58

*Rosalina irregularis* Hedley, Hurdle and Burdett, 1967: 45, pl. 11, figs 3a-b

***Rosalina parri* Collins 1974**

*Rosalina parri* Collins 1974: 46, pl. 3, figs 36a-c

***Piliolina* sp. aff. *P. opercularis* (d'Orbigny 1826)**

*Rosalina opercularis* d'Orb. 1826: 271, no. 7

*Piliolina? opercularis* Barker 1960: 184

***Cymbaloporeta bradyi* (Cushman 1915)**

*Cymbalopora poeyi* var. *bradyi* Cushman 1915: 25, pl. 10, figs 2a-c; pl. 14, figs 2a-c

*Cymbalopora bradyi* Albani 1968: 116, pl. 10, figs 15, 17-19

***Patellina corrugata* Williamson 1858**

*Patellina corrugata* Williamson 1858: 46, pl. 3, figs 86-89; Parr and Collins 1930: 90, pl. 4, figs 1-5

***Ammonia aoteanus* (Finlay 1940)**

*Strebulus aoteanus* Finlay 1940: 461

*Ammonia aoteanus* Hedley, Hurdle and Burdett 1967: 47, pl. 11, figs 4a-c; text figs 56-60

***Elphidium advenum* Cushman 1922**

*Elphidium advenum* Cushman 1922: 56, pl. 9, figs. 11-12; Albani 1968: 111, pl. 10, fig. 6

***Elphidium argenteum* Parr 1945**

*Elphidium argenteum* Parr 1945: 216, pl. 12, figs 7a-b

***Elphidium craticulatum* (Fichtel and Moll 1798)**

*Nautilus craticulatus* Fichtel and Moll 1798: 51, pl. 5, figs h-k

*Elphidium craticulatum* Albani 1968: 111, pl. 9, figs 19-20

***Elphidium crispum* (Linné 1758)**

*Nautilus crispus* Linné 1758: 709

*Elphidium crispum* Albani 1968: 111, pl. 10, fig. 7

***Elphidium depressulum* Cushman 1933**

*Elphidium advenum* var. *depressulum* Cushman 1933: 51, pl. 12, figs 4a-b

***Elphidium discoidale multiloculum* Cushman and Ellisor 1945**

*Elphidium discoidale* var. *multiloculum* Cushman and Ellisor 1945: 561, pl. 75, fig. 9.2; Albani 1968: 112, pl. 9, fig. 18

***Elphidium excavatum* (Terquem 1876)**

*Polystomella excavata* Terquem 1876: 25, pl. 2, figs 2a-f

*Elphidium excavatum* Hayward and Hollis 1994: 214, pl. 5, figs 1-12

***Elphidium granulosum* Collins 1974**

*Elphidium granulosum* Collins 1974: 43, pl. 3, figs 35a-c

***Elphidium gunteri corioense* Collins 1974**

*Elphidium gunteri* Cole *corioense* Collins 1974: 44, pl. 3, figs 34a-b

***Elphidium jenseni* (Cushman 1924)**

*Polystomella jenseni* Cushman 1924: 49, pl. 16, figs 4, 6

*Elphidium jenseni* Albani 1968: 112, pl. 10, fig. 8

***Elphidium limbatum* (Chapman 1907)**

*Polystomella macella* (Fichtel and Moll) *limbata* Chapman 1907: 142, pl. 10, figs 9a-b

***Elphidium macellum* (Fichtel and Moll 1798)**

*Nautilus macellus* Fichtel and Moll 1798: 66, pl. 10, figs h-k

*Elphidium macellum* Apthorpe 1980, pl. 29, fig. 11

***Elphidium poeyanum* (d'Orbigny 1839)**

*Polystomella poeyana* d'Orb. 1839: 55, pl. 6, figs 25-26

*Elphidium poeyanum* Albani 1968: 113, pl. 10, fig. 3

***Haynesina depressula* (Walker and Jacob 1798)**

*Nautilus depressulus* Walker and Jacob 1798: 641, fig. 33

*Elphidium simplex* Cushman 1933; Albani 1968: 113, pl. 10, fig. 4

***Parrellina imperatrix* (Brady 1881)**

*Polystomella imperatrix* Brady 1881: 66

*Elphidium imperatrix* Albani 1968: 112, pl. 9, figs 13-14, 17

***Nonionella auris* (d'Orbigny 1839)**

*Valvulina auris* d'Orb. 1839: 47, pl. 2, figs 15-17

*Nonionella auris* Cushman 1933: 45, pl. 10, figs 10-11

***Notorotalia clathrata* (Brady 1884)**

*Rotalia clathrata* Brady 1884: 709, pl. 107, fig. 8

***Rotalia perlucida* Heron-Allen and Earland 1913**

*Rotalia perlucida* Heron-Allen and Earland 1913: 139, pl. 13, figs 7-9; Albani 1968: 110, pl. 9, figs 12, 16

***Cibicides lobatulus* (Walker and Jacob 1798)**

*Nautilus lobatulus* Walker and Jacob 1798: 39, pl. 12, fig. 36

*Cibicides lobatulus* Cushman 1931: 118, pl. 21, fig. 3

***Accervulina inhaerens* Schultze 1854**

*Accervulina inhaerens* Schultze 1854: 68, pl. 6, figs 13-14; Yassini and Jones 1989, fig. 17, nos. 14-15

***Fursenkoina schreibersiana* (Czjzek 1848)**

*Virgulina schreibersiana* Czjzek 1848: 11, pl. 13, figs 18-21; Cushman 1939: 13, pl. 2, figs 11-20

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SPECIES	ZONE		OPEN MARINE																MIXED								UPPER TAMAR		TIDAL FLAT					
	1	2	3	4	5	6	7	8	19	27	30	31	33	34	11	12	13	14	15	16	17	18	22	10	20	21	24	25	26	28	29	32	35	
<i>L. limbatus</i>						X		X																										
<i>B. gibba</i>				X					X						X																			
<i>B. marginata</i>			X	X	X		X		X																									
<i>T. bradyi</i>					X	X	X																											
<i>H. victoriensis</i>					X																													
<i>A. quadrangularis</i>							X																											
<i>G. patelliformis</i>							X	X																										
<i>D. planoconvexa</i>			X		X	X		X																										
<i>P. inconspicua</i>	X	X	X	X	X	X	X	X		X																								
<i>L. dimidiatus</i>	X	X	X	X	X	X	X	X																										
<i>P. collinsi</i>					X	X	X																											
<i>R. anglica</i>					X			X																										
<i>R. australis</i>	X	X	X	X	X	X	X																											
<i>R. irregularis</i>	X								X																									
<i>R. parri</i>			X		X	X																												
<i>P. opercularis</i>					X	X																												
<i>C. bradyi</i>					X																													
<i>A. inadherens</i>													X																					
<i>E. advenum</i>		X	X			X																												
<i>E. argenteum</i>					X								X																					
<i>E. craticulatum</i>																																	X	

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